

Durham Research Online

Deposited in DRO:

14 November 2012

Version of attached file:

Accepted Version

Peer-review status of attached file:

Peer-reviewed

Citation for published item:

Rothwell, C. and Burford, B. and Morrison, J. and Morrow, G. and Allen, M. and Davies, C. and Baldauf, B. and Spencer, J. and Johnson, N. and Peile, E. and Illing, J. (2012) 'Junior doctors prescribing : enhancing their learning in practice.', *British journal of clinical pharmacology.*, 73 (2). pp. 194-202.

Further information on publisher's website:

<http://dx.doi.org/10.1111/j.1365-2125.2011.04061.x>

Publisher's copyright statement:

The definitive version is available at <http://onlinelibrary.wiley.com>

Additional information:

Use policy

The full-text may be used and/or reproduced, and given to third parties in any format or medium, without prior permission or charge, for personal research or study, educational, or not-for-profit purposes provided that:

- a full bibliographic reference is made to the original source
- a [link](#) is made to the metadata record in DRO
- the full-text is not changed in any way

The full-text must not be sold in any format or medium without the formal permission of the copyright holders.

Please consult the [full DRO policy](#) for further details.

Aim This aim of this paper was to explore new doctors' preparedness for prescribing.

Methods Multiple methods study including face-to-face and telephone interviews, questionnaires, and secondary data from a safe prescribing assessment (n=284).

Three medical schools with differing curricula and cohorts: Newcastle (systems-based, integrated curriculum); Warwick (graduate entry) and Glasgow (problem-based learning (PBL)), with graduates entering F1 in their local deanery.

The primary sample consisted of final year medical students, stratified by academic quartile (n=65) from each of the three UK medical schools. In addition an anonymous cohort questionnaire was distributed at each site (n=480), triangulating interviews were conducted with 92 clinicians and questionnaire data was collected from 80 clinicians who had worked with F1s.

Results Data from the primary sample and cohort data highlighted that graduates entering F1 felt under-prepared for prescribing. However there was improvement over the F1 year through practical experience and support. Triangulating data reinforced the primary sample findings. Participants reported that learning in an applied setting would be helpful and increase confidence in prescribing. No clear differences were found in preparedness to prescribe between graduates of the three medical schools.

Conclusion The results form part of a larger study 'Are medical graduates fully prepared for practice?' Prescribing was found to be the weakest area of practice in all sources of data. There is a need for more applied learning to develop skill-based, applied aspects of prescribing which would help to improve preparedness for prescribing.

Junior doctors prescribing: enhancing their learning in practice

Introduction

All doctors reach a point where they are legally responsible for prescribing. In the United Kingdom (UK), this is at the beginning of the two year Foundation Programme which immediately follows basic medical education. Prescribing is one of the biggest steps in practice in the transition from being a medical student to being a Foundation Year 1 (F1) doctor. From being unable to prescribe by law as medical students, new doctors have the responsibility for prescribing powerful, potentially high risk drugs[1]. Often it is junior doctors who prescribe most drugs in hospital[2] and their ability to do this safely and effectively is a concern both in the UK[3] and internationally[4]. A number of previous studies have found that new doctors are not as well prepared for prescribing as they might be[4],[5-13]. A study carried out on behalf of the General Medical Council checked 124,260 medical orders across nineteen hospitals in the UK, of these, 50,016 were written by junior doctors, 11,077 were found to have errors giving an error rate of 8.4%[9].

Prescribing could be considered simplistically to consist of two related but distinct components: the pharmacological knowledge (basic and clinical) which provides the knowledge base that is required to understand drug effects, interactions and contra-indications: and the practical and procedural skills of prescribing such as calculating the correct dosage and writing up a prescription on a drug chart. Both components are essential for safe and effective prescribing.

Adverse drug events are the leading cause of medical injury in hospital. Around half of these adverse events are thought to be due to problems in the prescriber's knowledge base and the other half due to problems in their practical skills and procedural skills in prescribing[14, 15]. As a result of growing concern about

prescribing in the UK, initially amongst clinical pharmacologists and, more recently, medical educationalists, a number of initiatives have been introduced. These include e-learning programmes that aim to provide targeted learning materials for medical students and junior doctors[16-18], greater involvement of hospital pharmacists in reviewing prescribing decisions and the use of electronic prescribing systems. Electronic prescribing systems reduce some errors but may introduce others[19, 20],- the 'novice' prescriber needs to have a certain amount of knowledge and experience to understand if a correct decision has been made and to know when to override the systems when needed.

In addition, the Medical Schools Council – the body that represents all UK Medical Schools - is currently working with the General Medical Council (the medical regulator in the UK) to introduce an exit examination in prescribing for all graduating medical students in the UK as part of the Medical Schools Assessment Alliance[21].

Some commentators have criticised particular types of undergraduate medical curricula for under-preparing their graduates for prescribing. A recent influential paper[7] reported more confidence about prescribing among medical students and recent graduates from 'Traditional' curricula compared to those who followed Problem Based Learning programmes. This survey, however, had a number of limitations and further work is needed in the UK to assess the validity of its findings.

Our paper considers the preparedness of medical graduates for prescribing. It draws on data which emerged from a larger study looking at new doctors' overall preparedness for practice.

Method

A range of quantitative and qualitative methods were used to provide a broad and triangulated view of new medical graduates' preparedness for prescribing. The study was carried out in three UK medical schools with different styles of curriculum (Newcastle – systems-based, integrated curriculum; Glasgow – Problem Based Learning; Warwick – graduate entry). A summary of the methods is presented in table 1 below:

Table 1: Summary of methods

Qualitative data			Quantitative data		
Graduates: Initial Interviews 4 month follow-up interviews 12 month follow-up interviews	Triangulating data: Telephone interviews with undergraduate tutors, educational supervisors, health managers	Triangulating data: Telephone interviews with clinical team members working with F1s.	Medical graduate questionnaire (administered at shadowing event at the end of medical school)	Triangulation questionnaire with clinical team members (inc. nurses, doctors, and pharmacists) working with the F1s.	Safe prescribing assessment(first round) Newcastle and Warwick only

Qualitative methods

Primary Sample

Participants

We aimed to recruit 20 medical graduates from each medical school as they were about to start their first year of practice. The sample was selected (initially randomly) from the graduating cohorts. In an attempt to ensure a spread of graduate capabilities the sample was stratified across the range of academic performance in

the penultimate year. Substitution was made if necessary, to ensure representation in terms of age, sex, ethnicity and disability. This provided a 'primary sample' of 65 graduates across all three medical schools, who were interviewed three times: before starting work (n=65 interviews achieved); after four months (n=55 interviews) and 12 months into practice (n=46 interviews).

Development of interviews

The semi-structured interview schedule for the initial interviews was developed following preliminary work involving focus groups with Foundation Year 1 and Foundation Year 2 doctors at each site. These interviews covered the following broad themes: anticipation of transition, areas of preparedness/un-preparedness and specific skills. Participants were asked in their first interview *'In what areas did you feel fully prepared to start work as a doctor?'*, *'Are there any areas that you feel worried about?'* and *'What additional training or information would you have liked to have received before starting to work as a doctor?'*

Follow-up interviews mirrored the initial interviews but focused on how expectations had been borne out. The interview schedules were developed following analysis of the previous interviews and discussion with researchers from all three sites. Themes which emerged from the initial interviews were explored in more detail in the four month follow-up interviews. These themes included: *prescribing; recognising acute illness; anatomical knowledge; practical skills; and hospital procedures*. Respondents were also asked in what areas mistakes were made. The theme of prescribing was also further explored in the third interviews when respondents were asked whether prescribing continued to be an issue at this stage and what they would recommend to help with this.

Procedure

The primary sample was invited to take part in the study by e-mail and by letter with an accompanying information sheet about the study. Written consent was taken at the start of the initial interviews with medical graduates, which were conducted face-to-face during their shadowing period, before taking up F1 posts. At the end of these initial interviews, consent was sought for follow-up telephone interviews, and then again for the final telephone interviews.

Triangulating Data from Clinicians

Qualitative triangulating data was also collected through telephone interviews (verbal consent taken) with participants from three groups: undergraduate tutors, foundation year educational supervisors and health managers (n=74 across all three groups).

Box 1: Definitions for participant groups

Undergraduate tutors are senior doctors with Consultant status working in hospitals or General Practitioners working in the community who are responsible for supervising medical students' clinical training.

Educational supervisors are senior doctors responsible for supervising Foundation Year 1 and Year 2 doctors' training.

Health managers are senior doctors with programme-level responsibility for groups of trainees e.g. clinical directors.

These participants were identified as having insight into the transition of medical graduates into F1. Areas covered in the interview were: perceived preparedness of graduates before starting F1, problems and strengths in performance during the first

four months of F1, how typical the current cohort of F1s are, and recommendations for changes to undergraduate programme.

Qualitative Data Analysis

Qualitative interviews were tape recorded with the participants' permission and transcribed verbatim. The transcripts were coded using QSR NVivo v7 software[22] and analysed using a grounded theory approach [23]. Themes were identified, discussed and agreed upon by researchers across all three sites from analysis of the first interviews. Analysis of the follow-up interviews refined existing themes and identified further themes, again discussed and agreed upon by all researchers.

Quantitative Methods

A questionnaire was developed from focus group data, literature review and adaptation of an existing tool and distributed to 480 new graduates during induction events. It addressed their perceptions of their preparedness for a number of areas of practice, with two of the 53 items concerned prescribing: *'Writing safe prescriptions for different types of drugs'* and *'Calculating drug doses'*. Response was on a five-point Likert scale ranging from 'Not at all prepared' to 'Fully prepared' with space for free-text comments[24].

For the purpose of triangulation, a separate questionnaire to be completed by clinicians, including pharmacists, who worked with F1s was developed through structured interviews with clinicians and pharmacists (n=18) and in consultation with experts. The questionnaire contained three-point categorical responses (prepared, unprepared, don't know) and free-text response questions about F1s' preparedness in particular areas of practice: clinical and practical skills (with specific questions on prescribing for pharmacists), error and communication. Questionnaires were sent to

managers of wards which hosted F1s, to cascade to relevant clinical team members and pharmacists. It is therefore unknown how many potential participants actually received the questionnaire.

Secondary data from a safe prescribing assessment undertaken by Newcastle and Warwick graduates in the early part of their first F1 placement was also examined. Glasgow graduates were not included due to a lack of resources. The assessment consisted of a written paper with eight questions addressing different aspects of prescribing (see table 2), and was marked by pharmacists. A score of 100% was required before progression to F2, but F1s could repeat it during the year without penalty.

Table 2: A breakdown of safe prescribing assessment questions. The questions referred to are in précised form:

Question 1:	Write a drug chart for a frail elderly gentleman admitted with pyelonephritis and requiring IV cefuroxime 750mg tds (to be given for 24hours and then reviewed). His usual medication is: aspirin 75mg each morning digoxin 0.0625mg each morning, paracetamol 1g qds.
Question 2:	Write a prescription for a patient going home on morphine sulphate modified release 30mg every 12 hours. A 14-day supply is required.
Question 3:	Write an IV prescription for an urgent loading dose of amiodarone for a 70 kg patient who is in atrial fibrillation and has not responded to digoxin, as a rate controlled infusion 5mg/kg to be administered in 250ml of fluid over 2 hours.
Question 4:	Complete an IV prescription for aminophylline for a 60 kg man with acute severe asthma who has not previously been treated with theophylline and has no known drug allergies.
Question 5:	Tick the box according to which formulations of morphine sulphate SR 20mg PO b.d. regularly, and morphine sulphate 10mg every four hours when required for breakthrough pain would be appropriate to prescribe.

Question 6:	What effect might you expect the co-administration of the following drugs to have on warfarin therapy (more than one effect may apply)?
Question 7:	Classify the following 9 antibiotics for administration to a patient who is documented to have had an anaphylactic reaction to penicillin.
Question 8:	Write a prescription on an inpatient drug chart for an adult patient with known renal impairment and an estimated GFR of 15ml/min who is admitted with an acute infection. Microbiology have recommended meropenem to be given as an IV injection over 5 mins. He has no known allergies.

Quantitative Data Analysis

Full details of analysis of the questionnaire data can be found elsewhere[24, 25].

Quantitative data from the graduates' questionnaire was analysed using SPSS v16.

Analysis of variance was carried out to compare the different medical schools.

Numbers of available responses limited analysis of the triangulation questionnaires (with clinical teams and pharmacists) and the prescribing assessment to examination of descriptive statistics

Results

Qualitative data

Primary sample data

Graduates from all three medical schools reported that prescribing was a significant area in which they felt under-prepared to start work as a doctor. All participants reported concerns about prescribing and these were present in all interviews from graduate through to 12 months in post. There was some development and perceived improvement throughout the year but concerns remained throughout in the following key areas.

Knowledge

Concerns included knowledge of drugs (including choices, interactions and side effects) and the mechanics of prescribing (calculating drug dosages and writing up the drug chart). Many of the graduates commented that they felt prescribing was a skill that needed to be learnt on the job because they were unable to gain hands-on experience as students by law.

“For me the major one [area] is practical pharmacology because we spent a lot of time studying pharmacology and I really don’t feel prepared for that in a practical kind of way” (Warwick graduate 4, first interview)

However by the end of the year F1s reported that, with experience, their confidence, knowledge and ability had improved. This was linked to increasing familiarity with commonly prescribed drugs and experience of more complex drug interactions, as well as teaching during F1 and support from colleagues. Reference materials were also used, such as the British National Formulary (BNF), Trust guidelines and online protocols. Some F1s, however, still felt that there were gaps in their knowledge, particularly in the case of little used rather than common or routine drugs.

“I was okay with the technicalities of how to prescribe, but my knowledge of appropriate drugs was and still is, I think very limited” (Warwick graduate 20, 4 month follow-up).

Knowledge gaps were related to the relevance, timing and context of undergraduate teaching on prescribing. Several respondents suggested that more practical teaching around common drugs, doses and interactions would have been useful as respondents felt they did not know enough about routine drugs, for example, through everyday scenarios to increase applied knowledge. Also mentioned were prescribing

insulin, fluids and infusions, and writing up drug charts under supervision. Formal teaching was still seen as important to develop these skills, as well as opportunities to practise.

“...what you learn at university is helpful but it is very different to what you need to know when you are prescribing day-to-day. There are lots of different protocols for things like warfarin and different antibiotics that we weren’t really familiar with ...” (Glasgow graduate 4, 4 month follow-up)

Some participants felt that their pharmacology teaching had been too early in their undergraduate programme to have relevance when they started practice. They did not make a distinction between basic pharmacology and clinical pharmacology teaching. Reinforcement and refresher courses in later years were seen as potentially helpful.

The practicalities of prescribing in practice

The importance of contextual knowledge that comes from experience was stressed at all sites; it was felt that prescribing errors were often related to practicalities, such as transcribing and errors made under time pressure. There was strong agreement that learning more about prescribing in an applied setting on the ward would have been helpful and increased their confidence as a new F1.

Errors in the area of prescribing

Respondents reported that they had made more errors in the area of prescribing than in any other area. These errors were minor, but they may still have an impact on patients. Some were attributed to pressures of working in a stressful environment, or fatigue, rather than lack of knowledge or practical skills. Pharmacists and nurses

often provided a safety net, recognising and correcting errors, with adverse consequences for patients being averted.

“I prescribed something to the wrong patient...but luckily it was only some peppermint capsules. But it was while I was on nights...so I was very tired”
(Newcastle graduate 93, 4 month follow-up)

“I went back and changed it when the nurse or the pharmacist had rung me usually because things are double-checked, triple checked...” (Warwick graduate 15, 4 month follow-up)

Triangulating data from clinicians

Respondents from all sites agreed with F1s' own views that they were under-prepared for prescribing, with gaps in pharmacological knowledge and problems calculating dosages and writing prescriptions. They commented that prescribing skills can only be developed through practice in the workplace with real patients.

“...although we teach them about drug treatments... you are never quite sure how much that will generalise out into real life clinical situations that they will come across ...probably an area where there is a gap”
(Newcastle Undergraduate Tutor 1)

“They don't know about pharmacology and therapeutics...” (Warwick Undergraduate Tutor 3)

Quantitative data

Responses were received from 69% (480/698) of the total graduating cohort of students from the three medical schools (the number of people who received questionnaires is not known because of the method of distribution, so the effective

response rate is likely to be higher). Overall frequencies of responses to the two questionnaire items are shown in table 3. Full results from the questionnaire are presented elsewhere[24],[25].

Table 3: Frequencies of responses to graduates' questionnaire items concerning prescribing

How prepared do you feel for...	1 'Not at all prepared'	2	3	4	5 'Fully prepared'	Total
q15 Writing safe prescriptions for different types of drugs	21	118	212	110	15	476
q16 Calculating drug dosages	54	158	168	82	15	477

The two items in the graduates' questionnaire which related to prescribing both had means below the mid-point of the scale indicating low preparedness (see table 4).

These were two of the six lowest-rated items for respondents from each medical school (the other four lowest-rated items related to: writing out a cremation form; complex practical procedures; structures and functions of the NHS in practice; and complementary therapies).

Neither of the two prescribing items showed a significant effect of medical school.

The first question related to the procedural element – writing prescriptions, while the second, calculating drug dosages, related more to the underlying knowledge base, although it may also have a procedural element.

Table 4 Frequencies of responses to graduates' questionnaire items concerning prescribing.

Glasgow			Newcastle		Warwick	
	Mean	SD	Mean	SD	Mean	SD
Q15 Writing safe prescriptions for different types of drugs	2.893	.963	2.982	.863	2.983	.836
Q16 Calculating drug dosages	2.252	.964	2.982	.956	2.574	.890

To put these figures in context, the highest overall mean score was 4.41 (respecting the roles and expertise of other health and social care professionals) and the lowest was 2.62 (Writing out Part A of a cremation form).

Results of safe prescribing assessment

Results from the prescribing assessment reinforced a picture of graduates being under-prepared. Only 19% of the Newcastle graduates (n=229) and 16% of Warwick graduates (n=55) passed (i.e. answered all eight questions correctly) at the first attempt. However, only 43% of the Warwick cohort and 62% of the Newcastle cohort answered six or more questions correctly, indicating the stringency of the high pass rate.

The largest differences between results from the two cohorts were on three questions (Q2: 46%, Q3: 37% and Q4: 24%). These questions related to the prescription of morphine for home use, intravenous amiodarone and intravenous aminophylline. (See table 2 and 5). Despite the fact that these three questions all relate to significant

patient safety issues, it is important not to draw unwarranted inferences about quality of teaching at the respective medical schools, bearing in mind that there were also some large differences between the remainder of the cohorts.

Table 5: Frequency and percentage of correct responses to each question.

		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Newcastle graduates	Correct	184	176	212	122	174	171	211	176
	% correct	80 %	77 %	93 %	53 %	76 %	75 %	92 %	77 %
	Rank	3	4	1	8	6	7	2	4
Warwick graduates	Correct	42	17	31	16	35	40	46	39
	% correct	76 %	31 %	56 %	29 %	64 %	72 %	83 %	71 %
	Rank	2	7	6	8	5	3	1	4
Remainder of Northern Deanery Foundation School cohort	Correct	73	54	87	50	68	65	76	70
	% correct	66 %	49 %	78 %	45 %	61 %	59 %	68 %	63 %
	Rank	3	7	1	8	5	6	2	4
Remainder of Coventry and Warwickshire Foundation School cohort	Correct	22	14	15	13	20	15	21	18
	% correct	88 %	56 %	60 %	52 %	80 %	60 %	84 %	73 %
	Rank	1	7	5	8	3	5	2	4

Triangulating Quantitative Data

Eighty triangulation questionnaires were returned from clinical team members and pharmacists across the three sites. Perceptions of F1s' prescribing skills differed between the professional groups interviewed, with pharmacists identifying problems in most areas of prescribing while doctors and nurses did not. There were few responses to the pharmacist specific questionnaire, but this also indicated a trend toward perceptions of under preparedness. Pharmacists identified problems around basic tasks such as taking drug histories, calculating doses, choosing appropriate drugs and completing drug charts and prescriptions clearly and legibly.

“Many required amendment with respect to dose and appropriate formulation etc” (Glasgow triangulation questionnaire respondent, G8, pharmacist)

Discussion

This paper has confirmed that graduating doctors do not feel, nor are they perceived to be, fully prepared for prescribing. It demonstrates that this lack of preparedness persists throughout their first Foundation Programme year and is comparable among graduates who have trained under three different curricula. Some possible reasons for the findings are suggested.

A consistent pattern of under-preparedness for prescribing emerges from the range of evidence. All sources of data reported here indicated that preparedness for prescribing was a weakness. This suggests that the often questioned validity of self reports[26] is less of a problem in this study, although preparation in this case is mostly related to confidence rather than prediction or assessment of

performance[27],[28]. Similar findings that prescribing is an area of weakness have been reported elsewhere[4, 6, 7, 10, 13, 29-31].

No clear difference was found between graduates of the three medical schools, indicating that differences in the approaches of those schools do not influence perceptions of preparedness for prescribing. There were also no indications of a systematic variation in the perceived preparedness of respondents in relation to their academic ranking.

There is no doubt that the transition from student to junior doctor is a huge leap in terms of responsibility[32]. Skills and procedures learnt in artificial environments are being carried out for real, often under time pressures and with high workloads.

One of the main findings that emerged from the qualitative data was that prescribing is a skill which is not just based on the recall and application of declarative knowledge, but is a practical skill, situated in the working environment. Many of the graduates reported that prescribing was something they could not really 'get to grips' with as a classroom subject, but when in practice it became relevant and important, suggesting it is best learnt in the clinical setting. This is borne out by other research in this area both internationally[33, 34] and in the UK[5],[9],[35]. Development of prescribing skills may require the contextual variables presented by real patients (e.g. co-morbidity; challenging home situations; cognitive impairment) to be present during learning – either in the workplace, or potentially in a simulated environment, if the simulation has the appropriate level of fidelity. Prescribing does not take place in isolation from other clinical and patient management decisions - the writing of a prescription is the culmination of a sequence of clinical decisions, and the precursor to others[36].

Whilst participants had commented that pharmacology teaching had been too early in their course, they may have been referring to basic pharmacology rather than clinical pharmacology, and it may be that their difficulty was translating this basic science into a patient-centred environment, usually taught through 'clinical pharmacology and therapeutics'. It may be telling though that participants did not make this distinction, referring just to 'pharmacology'. Whilst there is teaching about both basic pharmacology and clinical pharmacology and therapeutics, students still perceive themselves not to have had enough, and this may in part be because the teaching and learning is not grounded in practice and is more theoretical than practical. Spiral reinforcement of the pharmacology learning in ward situations is probably an ideal.

The skill-based nature of prescribing is reinforced by the errors described by F1s. These errors mainly fell into the category of 'slips and lapses'[9],[37],[38], errors which occur not because of a gap in knowledge but because the environment does not preclude behavioural errors. For example, time pressure may lead to an omission in a dosage calculation, or a drug card being incorrectly transcribed. Such errors are often remediated through systemic change rather than individual action. Hospitals have developed a number of safeguarding measures to help minimise errors in prescribing such as the use of pharmacists. Interestingly many of the F1s who were interviewed in this study reported that they relied upon pharmacists and nurses to double check what they were prescribing and to alert them of any errors, thus reducing risks to patients. A similar finding has been reported elsewhere[9]. It could be that some anxiety about the responsibility of prescribing may reduce overconfidence and make new prescribers more cautious and more likely to seek help from seniors, pharmacists and the BNF.

Decision support systems are potentially helpful for avoiding such errors. However, initiatives such as e-prescribing for doctors are not yet in full use and one could

argue that prescribers cannot rely solely upon such decision support aids – doctors must still have a certain amount of background knowledge and recognition to be able to understand if an incorrect answer has been given and to know when to override an alert[2, 39].

Preparedness may be improved by increasing the number of opportunities to develop the skill-based, applied aspects of prescribing. This experience could be provided through the use of simulated activity, or allowing students on clinical placements to write up prescriptions and drug charts which would then be checked and signed by a doctor. Both would provide a controlled yet ‘real’ environment in which to gain experience. The introduction of Student Assistantships by the GMC may provide a valuable opportunity for medical students to practice the skill of prescribing safely[40]. This may complement developments in e-learning [16, 17],[18], thus allowing the practical relevance of those learning materials to be recognised.

Future Research

The ways in which prescribing skills are learnt and developed, and the times at which students are most receptive to learning these skills, are worthy of more detailed study. The use and usefulness of interventions such as the safe prescribing assessment, on-ward teaching and the role of simulation may identify how prescribing and clinical pharmacology are best learnt, and best translated into practice.

Limitations

While the breadth of data collected provides strength, the study does have limitations. Practical considerations meant the prescribing assessment could not be run in Glasgow to provide a comparison of all three sites.

There were no specific questions to ascertain whether participants used any form of electronic prescribing in their placements.

Ethical Approval

Full ethical approval was gained from Cambridgeshire 1 Research Ethics Committee.

Acknowledgments

We thank all the medical graduates who participated in this study and all the clinicians, pharmacists and educators who took part in the interviews and completed questionnaires. The study was funded by the General Medical Council.

References

1. Maxwell S, Walley T. Teaching Safe and Effective Prescribing in UK Medical Schools: a Core Curriculum for Tomorrow's Doctors. *Br J Clin Pharmacol* 2003; 55: 496-503.
2. Caruba T, Colomes I, Gillaizeau F, Bruni V, Korb V, Prognon P, Begue D, Durieux P, Sabatier B. Chronology of prescribing error during the hospital stay and prediction of pharmacist's alerts overriding: a prospective analysis. *BMC Health Services Research* 2010; 10: 13.
3. O'Shaughnessey L, Haq I, Maxwell S, Llewelyn M. Teaching of Clinical Pharmacology and therapeutics in UK medical Schools: current in 2009. *Br J Clin Pharmacol* 2010; 70: 143-48.
4. Hilmer SN, Seale JP, Le Couteur DG, Crampton R, Liddle C. Do Medical courses adequately prepare interns for safe and effective prescribing in New South Wales public hospitals? . *Intern Med J* 2009; 39: 428-34.
5. Chidi N, Molokwu CN, Sandiford N, Anosike C. Safe Prescribing by Junior Doctors *Br J of Clin Pharmacol* 2008; 65: 615-16.

6. Han WH, Maxwell SRJ. Are Medical Students adequately trained to prescribe at the point of graduation? Views of 1st year Foundation Doctors. *Scott Med J* 2006; 51: 27-32.
7. Heaton A, Webb DJ, Maxwell SRJ. Undergraduate Preparation for prescribing the views of 2413 UK medical students and recent graduates. *Br J Clin Pharmacol* 2008; 66: 128-34.
8. Coombes ID, Mitchell CA, Stowasser DA. Safe Medication practice: attitudes of medical students about to begin their intern year. *Med Educ* 2008; 42: 427-31.
9. Dornan T, Ashcroft AD, Heathfield H, Lewis P, Miles J, Taylor D, Tully M, Wass V. An indepth investigation into causes of prescribing errors by foundation trainees in relation to their medical education - EQIP study http://www.gmc-uk.org/FINAL_Report_prevalence_and_causes_of_prescribing_errors.pdf_28935150.pdf [accessed 23.2.10]. 2009.
10. Matheson C, Matheson D. How well prepared are medical students for their first year as doctors? The views of consultants and specialist registrars in two teaching hospitals. *Postgrad Med J* 2009; 85: 582-89.
11. Lempp H, Seabrook M, Cochrane M, Rees J. The Transition from Medical Student to doctor: Perceptions of final year students and pre-registration house officers related to expected outcomes. *Int J Clin Pract* 2005; 59: 324-9.
12. Wall D, Boshaw A, Carolan J. From undergraduate Medical Education to Pre Registration house officer: How Prepared are students? *Med Teach* 2006; 28: 435-9.
13. Mitchell C. How Prepared are medical graduates to begin prescribing? . *Intern Med J* 2009; 39 425-27.
14. Coombes ID, Stowasser DA, Coombes JA, Mitchell C. Why do interns make prescribing errors? A qualitiative study. *Med J Aust* 2008; 188: 89 - 94.
15. The Audit Commission. A Spoonful of Sugar: Medicines Management in NHS Hospitals. In: The Audit Commission, 2001.
16. www.prescribe.ac.uk. [accessed 10.5.11].
17. http://www.e-lfh.org.uk/projects/safe_prescribing/index.html. In, [accessed 1/5/09].
18. <http://www.cpt-prescribe.org.uk/>. In, [accessed 1/5/09].
19. Ash JS, Berg M, Coiera E. Some unintended consequences of information technology in health care: the nature of patient care information system-related errors. *J Am Med Inform Assoc* 2004; 11: 104-12.
20. Savage I, Cornford T, Klecun E, Barber N, Clifford S, B Dean Franklin. Medication Errors with electronic prescribing (eP): Two views of the same picture. *BMC Health Services Research* 2010; 10: 135.
21. www.medschools.ac.uk/MSA-AA/pages/default. [accessed 20.4.11].

22. NVivo. Using NVivo in qualitative research.: QSR International, Melbourne, 2002.
23. Glaser B, Strauss A. The Discovery of Grounded Theory. New York, 1967.
24. Illing J, Morrow G, Kergon C, Burford B, Spencer J, Peile E, Davies C, Baldauf B, Allen M, Johnson N, Morrison J. How prepared are medical graduates to begin practice? A comparison of three medical schools. Final summary and conclusions for the GMC Education Committee [http://www.gmc-uk.org/about/research/REPORT%20preparedness%20of %20medical %20grads.pdf](http://www.gmc-uk.org/about/research/REPORT%20preparedness%20of%20medical%20grads.pdf) [accessed 27.4.09]. 2008.
25. Illing J, Morrow G, Kergon C, Burford B, Spencer J, Peile E, Davies C, Baldauf B, Allen M, Johnson N, Morrison J, Donaldson M, Whitelaw M, Field M. How prepared are medical graduates to begin practice? A comparison of three medical schools. Final project report for the GMC Education Committee. 2008.
26. Colthart I, Bagnall G, Evans A, Allbutt H, Haig A, Illing J, McKinstry B. The effectiveness of self-assessment on the identification of learner needs, learner activity and impact on clinical practice. BEME Guide no. 10 Med Teach 2008; 30: 124-45.
27. Morgan PJ, Cleave-Hogg D. Comparison between medical students' experience, confidence and competence. Med Educ 2002; 36: 534-39.
28. Stewart J, O'Halloran C, Barton JR, Singleton SJ, Harrigan P, Spencer J. Clarifying the concepts of confidence and competence to produce appropriate self-evaluation measurement scales. Med Educ 2000; 34: 903-09.
29. Albert M, Hodges B, Regehr G. Research in Medical Education : Balancing Service and Science. Adv Health Sci Educ Theory Pract 2007; 12: 103.
30. Evans DE, Wood DF, Roberts CM. The effect of an extended hospital induction on perceived confidence and assessed clinical skills of newly qualified pre-registration house officers. Med Educ 2004; 38: 998-1001.
31. Cave J, Goldacre M, Lambert T, Woolf K, Jones A. Newly qualified doctors' views about whether their medical school had trained them well BMC. Med Educ 2007; 7: 50.
32. Brennan N, Corrigan O, Allard J, Archer J, Barnes R, Bleakley A, Collett T, Regan de Bere S. The transition from medical student to junior doctor: today's experiences of tomorrow's doctors. Med Educ 2010; 44: 449-58.
33. Oshikoya KA, Senbanjo IO, Amole OO. Interns' knowledge of clinical pharmacology and therapeutics after undergraduate and on-going internship training in Nigeria: a pilot study BMC Medical Education 2009; 9: 50.
34. Richer MC, Tichelaar J, Geijteman ECT, de Vries TPGM. Teaching Clinical Pharmacology and therapeutics with an emphasis on therapeutic reasoning of undergraduate medical students. Eur J Clin Pharmacol 2008; 64: 17-24.
35. Tobaigy M, McLay J, Ross S. Foundation Year 1 doctors and clinical pharmacology and therapeutics teaching A retrospective view in light of experience

Br J Clin Pharmacol 2007; 64: 363-72.

36. Aronson JK. Prescription for better prescribing Br J Clin Pharmacol 2006; 61: 487-91.

37. Reason J. Human Error. Cambridge: Cambridge University Press, 1990.

38. Dean B, Schachter M, Vincent C, Barber N. Causes of prescribing errors in hospital inpatients: a prospective study. Lancet 2002; 359: 1373-78.

39. Donyai P, O'Grady K, Jacklin A, Barber N. The effects of electronic prescribing on the quality of prescribing. Br J Clin Pharmacol 2008; 65: 230-7.

40. General Medical Council. Tomorrow's Doctors. http://www.gmc-uk.org/static/documents/content/TomorrowsDoctors_2009.pdf 2009.